Technical Appendix 10.3: Calculating Standardised Wind Speed

10.1 In order to derive appropriate noise limits the ETSU-R-97 guidance requires the correlation of background noise survey data with wind speed data referenced to 10 m height. In contrast to this, acoustic emission measurements on wind turbines are undertaken in accordance with international standard IEC 61400-11, 'Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques'[1], which specifies that the turbine noise emission should be reported as a function of 'standardised' wind speed at 10 m height. In practice this translates as extrapolation of wind speed at hub height down to 10 m height using a specified, and fixed, relationship.

10.2 The use of a fixed relationship between hub height and 10 m wind speed means that potential exists for the background noise data and acoustic emission data to be misaligned i.e. a wind speed measured at 10 m height is not necessarily equivalent to a 'standardised' 10 m wind speed of the same magnitude, with the difference depending upon the site specific shear exponent (the rate of change of wind speed with height).

10.3 To account for the effects of wind shear, the background noise data is referenced to the same wind speed as the acoustic emission data. This approach is defined as appropriate, both by a group of independent acoustic consultants who have undertaken work on behalf of wind farm developers, local planning authorities and third parties in the IoA Bulletin, and in the subsequent IoA GPG. The methodology outlined below is followed to convert the wind speed measured concurrently with the background noise data to 'standardised' 10 m height:

- Extrapolate the wind speed from the measurement height to the proposed hub height by use of a calculated wind shear exponent. The wind shear exponent is a commonly used, empirically based, engineering description of the rate of change of wind speed with height and may vary according to atmospheric conditions and be affected by interactions between ground features and the wind flow. The hub height wind speed for each 10 minute period may be calculated from the measured wind speed and the calculated wind shear exponent as follows:

$$v_{hub} = v_{H1}\left(\frac{h_{hub}}{h_{H1}}\right)^{\alpha}$$

Where: v_{H1} = measured wind speed
v_{hub} = wind speed at proposed hub height
h_{H1} = measurement height
h_{hub} = proposed hub height
a = calculated wind shear exponent from measured site data

- The 'standardised' 10 m wind speed is determined from the calculated hub height wind speed according to the procedure specified in IEC 61400-11. The 'standardised' wind speed is essentially a proxy for hub height wind speed (the primary driver of noise emission from the turbine) and is found by extrapolating the hub height wind speed to 10 m height according to the following formula:

[1] 'Wind turbine generator systems – Part 11: Acoustic noise measurement techniques', IEC 61400-11:2003 (Amendment 1: 2006)

$$v_S = v_Z \left[\frac{\ln \frac{z_{ref}}{z_{0ref}}}{\ln \frac{z}{z_{0ref}}} \right]$$

Where: v_s is the 'standardised' wind speed
v_z is the wind speed at height z (the hub height wind speed)
z_{0ref} is the reference roughness length (0.05 m)
z_{ref} is the reference height, 10 m
z is the proposed hub height

- The resulting 'standardised' 10 m wind speed is correlated with the measured background noise survey data.